Development of Grid Connection Policy for Micro/Mini Hydro Plants in Nepal

**Abstract**

The connection of Micro/ Mini hydro and Mini grids to the national grid has been discussed for a long time both by subject matter experts and generalists in Nepal. It is seen as a solution to alleviate the current power crisis faced by the country, albeit to a limited extent some have argued. In addition, there are proponents that see it as a potential source of income for rural areas. Currently, there are two grid connection projects that are ongoing and expected to be completed by mid 2017.

**Introduction**

Nepal is known the world over for having successful community-led micro hydro plants that have transformed a significant section of its remote and hilly districts. Nepal’s green energy, which totals 36 MW today, has not only brought lights to more than 300,000 families in remote areas away from the grid, it has created an environment conducive to new economic activities, relieved people of drudgeries, improved their health and helped better children’s education.

Unfortunately, as soon as the national grid reaches a micro hydro catchment area, things start falling apart. Communities are divided between supporting the expansion of the national grid and maintaining the micro hydro that serves them. Some people eventually start using grid electricity thus further depriving an already financially stressed off grid system. Consequently, many micro hydro installations cannot compete with the grid and stop their operations. In some cases however, it has been observed that the communities have reverted back to micro hydro as the grid is plagued with a lot of outages due to regular load shedding. This unfortunate situation is due to the lack of coordination between the two largest governmental organizations involved in rural electrification. This is where a solution is urgently needed. Alternative Energy Promotion Center (AEPC) had started working on the national grid of MHPs. However, the reluctance of the NEA reflected in the directives of senior NEA management was not conducive for grid connection. AEPC thought of interconnecting MHPs and then only connecting the unified system to the grid, thereby ensuring the continuous operation of the micro hydro projects it had supported as well as utilizing the national resources.

**Micro Hydro Interconnected Mini Grid**

AEPC has successfully implemented a Micro Hydro interconnected Mini Grid in Baglung district in 2012. It interconnects 6 MHPs having capacity ranges from 9kW to 26kW. The interconnection has been done at 11 kV and is synchronized through a micro-controller based control panel. At present, the MHPs in the mini-grid are working properly, with proper regulation of the voltage and frequency at their prerequisite levels. It is managed and operated by a co-operative called *UrjaUpatyaka* Mini-grid Co-Operative. Upon successful implementation of Baglung Mini-Grid, AEPC has recently commissioned one more mini grid in Gulmi District of Nepal. The Gulmi Mini Grid interconnects two micro hydro plants with a capacity of 135 kW and 85 kW each. The main objective of interconnecting the two MHPs is to bring a surplus power of 135 kW to the load center of 85 kW plant where there is a huge power deficit.

The lessons from the two mini grids has built confidence that the micro hydro interconnected mini grid is a viable solution and it can be developed as a permanent source of electricity when the national grid is located away from the load centre. The anticipated benefits after the development of the mini grid are as follows:

* Balancing the power from existing micro-hydro power.
* Providing better quality electricity for the foreseeable future.
* Entrepreneurs encouraged to start micro/small enterprises.
* Income generation from surplus power.
* Sustained use of micro-hydro plants.
* Increase in revenue for the local development government agency.

To disseminate this technology nationwide, Nepal needs to develop the grid synchronizable Electronic Load Controller (ELC) domestically. AEPC is also looking to connect existing mini grids to the national grid. For example, Baglung mini grid, 33 kV national grid line is available 600 meters from the nearest point of interconnection. Similarly the 11 kV national grid line is available 1 kilometer away from the Gulmi mini grid. However the cost of interconnection at 33 kV is very high. It is expected that 11kV grid will be available in near future in the vicinity of Baglung mini grid. AEPC will initiate the interconnection of Baglung mini grid to national grid upon availability of 11 kV line.

**Policy Breakthrough for Grid Connection**

The Government of Nepal’s current energy related policies divide rural electrification into two sub-sectors, largely defined as grid-based (on-grid) and isolated (off-grid). On-grid rural electrification is administered under the Ministry of Energy (MoE) through the Department of Electricity Development (DoED) as the regulator and promoter; and the Nepal Electricity Authority (NEA) as the vertically integrated agency responsible for national implementation. The Alternative Energy Promotion Centre (AEPC), under the Ministry of Science, Technology and Environment (MOSTE), administers off-grid electrification through renewable energy. Therefore, grid connection of isolated micro hydro requires close collaboration between NEA and AEPC. When AEPC approached NEA regarding the grid connection of MHPs, NEA raised technical concerns. They argued that small plants may create technical and managerial hassles. Moreover they also raised safety concerns, specifically NEA was worried that micro hydro may back feed power when the mains fail. It was raised that the substation repair and maintenance technician may be in danger if micro hydro continues its supply intentionally or unintentionally. AEPC prepared a Technical Standard for grid connection taking into consideration all issues raised by NEA. Thereafter, the NEA technical team, micro/mini hydro practitioners and experts from academic institutions reviewed it. The Technical Standard clearly addresses the safety issues by introducing the Rate of Change of Frequency Relay (ROCOF) as the Loss of Main Relay. After approval of “[Micro Hydro Projects Interconnection Equipment Standards and Specifications](file:///C:\Users\user\AppData\Local\Microsoft\Windows\Temporary%20Internet%20Files\Content.Outlook\DESJSL6P\MHP%20Interconnection%20Stnd%20&%20Specification_final.doc)” from NEA, AEPC performed a [financial analysis](file:///C:\Users\user\AppData\Local\Microsoft\Windows\Temporary%20Internet%20Files\Content.Outlook\DESJSL6P\AEPC_PPA%20calculations%20v2.xlsx) for grid connection of MHPs. The study has concluded that micro hydro installations with more than 25 kW capacity, at a distance of less than 3 km from the existing 11kV line, are financially viable for grid connection. It was assumed that the micro hydro PPA rate will also be the same as the posted rate for hydropower projects up to 25MW capacity. The outcome of the financial analysis is presented in below table:

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| --- | --- | --- | --- | --- | --- | --- |
| **Category of MHP** | **Maximum interconnection distance in (Km)** | **Recommended interconnection voltage (kV)** | **Conductor type** | **Cost of Interconnection (NRs.)** | **IRR** | **NPV** |
| 1 to 25 kW | 1 | 0.4 | Weasel or higher rating | 2,667,500.00 | 26.70% | 4,262,554.10 |
| 25 to 50 kW | 2 | 11 | Weasel or higher rating | 4,632,500.00 | 32.10% | 9,930,108 |
| 0.5 | 0.4 | Rabit or higher rating | 2,614,500.00 | 57.54% | 13,482,108.20 |
| 50 to 75 kW | 3 | 11 | Squirrel | 5,934,500.00 | 39.06% | 16,923,662.30 |
| 75 to 100 kW | 4 | 11 | Squirrel | 7,438,500.00 | 42.11% | 23,513,216.40 |

For financial analysis it is assumed that i) Loan Tenure – 10 years, ii) Economic life of plant- 15years, and iii) PPA tenure- 10 years.

Based on Technical and Financial analysis, the following recommendations have been made:

* Take or Pay /Give or Pay clauses shall not be applied to both parties.
* For a capacity up to 500 kW, Metering Instruments (CT, PT) and Bi-directional Meter accuracy class shall be at least 0.5 classes and shall be borne by the User. CT shall be separate cores (one for main and another for check meter) but PT may be used for measurement by one core and protection by another core.
* Operation and maintenance of Circuit Breaker, Isolators and Earthing switch at connection point shall be done by Grid User.
* Communication channel i.e. telephone CDMA/ PSTN set shall be maintained by Grid User to NEA’s nearest connecting substation and cost shall be borne by User
* Performance Guarantee shall not be applied
* Liquidated Damage clause shall not be applied for such PPA
* Transmission line loss occurred if any, due to project/Mini grid in NEA system shall not be allocated because of small amount of power injected.
* Grid Impact Study shall not be necessary for projects and mini grid less than 500 kW.
* Operation procedure shall establish safety procedure for shut down and maintenance. Isolator and earthing provision are to be made for safe practice.
* For the connection to grid, plant should have provision of synchronous generator

Based on these recommendations from the AEPC and NEA joint working team; NEA board has made the following decisions grid connection:

1. Upon request from AEPC, to study and comment on the technical guidelines prepared by AEPC on above subject; a working committee constituting of NEA suggested for Mini Grid or Micro Hydro plant interconnection to the national grid be upon fulfillment of conditions under clause “A” (points “Ka” to “Da”).
2. Approval to be given to allow plants with sizes less than 100kW to also be interconnected to INPS. But such plants shall obtain permission from NEA for “Interconnection facilities” prior to mandatorily installing “Synchronous Generator”.
3. Power purchasing rate for Micro Hydro Power Plants up to 100kW size shall be similar to conditions and Power Purchasing posted rate fixed by NEA for plants up to 25MW size i.e. 4.8 cents/kWh for 8 month (wet season) and 8.4 cents/kWh for 4 month (dry season).
4. Micro Hydro power plants with sizes up to 100kW and beyond and up to 500kW, which received subsidy shall be treated separately

The policy breakthrough has opened the door for the connection of micro hydro to the grid. Although the NEA Board has already made this landmark decision, a few words in the decision minutes has caused serious problems in the actual implementation.

**Procedure for Grid Connection**

NEA requires that the following procedures be followed for grid connection:

1. Application from developer for grid connection to utility authority (NEA). The application should also include the following documents.
2. Energy and capacity of the participating power plants (as per Feasibility reports, as per the present operation data and proposed / forecasted generation
3. Interconnection diagrams, and individual power plant electrical SLD
4. Proposal for operation of the Interconnection point, metering and delivery point.
5. Relevant letters of approval from VDC/DDC (local authorities) for use of the waters.
6. Registration data (legal issues) cooperative / company etc.
7. Environmental issues / clearances according to legal provision if any
8. Support letter from AEPC (in the case that micro hydro has received a subsidy from AEPC) for interconnection works.
9. Letter of Intent from bank
10. Authorization for a person to deal with the PPA. For grid connection of mini grid, the authorization letter from all the participating plants is required.
11. The grid utility authority finalizes the connection agreement and operating procedure.
12. If entire criterion met, the grid utility authority call micro hydro or mini grid owner for PPA.
13. The developer has complete responsibility for procurement, installation of equipments for grid connection.
14. Testing and commissioning of grid connection is carried out in the presence of NEA authority.
15. If all the conditions are met, the NEA gives dispatch instructions.

**Issues and Barriers**

AEPC and NEA anticipate that inter-connection of Micro/ Mini hydropower and Mini Grid is a small step but will have a ripple effect in rural electrification in Nepal. But there are quite a few barriers that have to be overcome:

1. Though the NEA Board made a landmark decision, implementation has proved to not be easy because of the many requirements that were originally intended for larger hydropower projects. If Nepal really wants to make use of the energy generated by micro hydro, the procedures have to be simplified for and undemanding of rural people.
2. Availability of grid synchronizable ELC for grid connection of MHP
3. NEA has allowed grid connection voltage above 11kV or more. They also concluded that there should be mandatory use of Vacuum Circuit Breaker (VCB) in 11kV which alone cost around $ 12,000. After successful completion of grid connection of two ongoing micro hydro projects, AEPC and NEA will look for revision of Technical Standard and look the possibility whether grid connection will be allowed at 400V or not. Also look possibility of replacement of VCB with relay operated load break switch (LBS) which is much cost effective than VCB.
4. The Community Electrification Programme of NEA has set up tariff of 3.8 cents/kWh which is much cheaper than the purchase tariff rate to the NEA from micro hydro (4.8 cents for 8 month and 8.4 cent for 4 month). In this case micro hydro only focus to sell energy to NEA and not to provide service to its own consumer. The MHP consumer also prefers to purchase electricity at 3.8 cents/kWh from NEA. This tariff difference will bring a argument to NEA to set up new export tariff rate for energy exchange from NEA to micro hydro consumers.

**Conclusion**

Two pilot MHPs will be interconnected by August 2017. The learning from pilot projects would help to revise the "[Micro Hydro Projects Interconnection Equipment Standards and Specifications](file:///C:\Users\user\AppData\Local\Microsoft\Windows\Temporary%20Internet%20Files\Content.Outlook\DESJSL6P\MHP%20Interconnection%20Stnd%20&%20Specification_final.doc)". In the revised edition, the learning from regional countries such as Srilanka will be also incorporated. In Sri Lanka, MHP has been interconnected at 400V in and CT/PT accuracy class of 1 instead of 0.5 has been already tested and successful. The revision of standard based on own and other countries learning would make more financial attractive of interconnection of MHP to national grid in Nepal.

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